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Title: Nursing Workload in ICUs and the Influence of Patient and Nurse Characteristics

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Abstract

Background: Understanding factors that can potentially influence patient care and nursing workload in intensive care units is important. Previous studies have shown contradictory outcomes about the relationships between nursing workload and patient and nurse characteristics.

Aims and objectives: This study aimed to investigate nursing workload in intensive care units and examine the association between this in relation to patient and nurse characteristics.

Design: A cross-sectional design was conducted.

Methods: All nurses who were working in the intensive care units of five hospitals and met the study criteria were enrolled in the study. Two demographic questionnaires collected nurse and patient demographic information. The Nursing Activities Score was applied to determine nursing workload in three shifts (morning, evening, night) for each nurse. Data were analyzed using the independent sample t-test, one-way analysis of variance, and multivariable linear regression analysis.

Results: The Nursing Activities Score was calculated for 509 patients who were under the care of the 105 intensive care unit nurses. The mean (SD) nursing activities score was 72.84% (22.07%). Morning shifts, male patients, medical treatments, and referred patients from the emergency ward and other intensive care units imposed a higher workload for nurses. Specifically, female nurses, increased number of patients receiving care, and increased patient length of intensive care unit stay were directly associated with increased nursing activities scores. Work in surgical and burn intensive care units were inversely associated with the nursing activities score.

28 **Conclusion:** This study suggests that the workload of nurses in intensive care units can be affected
29 by both nurse and patient characteristics.

30 **Relevance to clinical practice:** The findings can be used to ensure appropriate staffing of
31 intensive care units by nurses. However, nurse and patient characteristics should not be considered
32 as the only factors which influence nursing workload in intensive care units.

33 **Key words:** *Critical care; ICU; Intensive care units; Nursing; Workload*

34

1. INTRODUCTION

Health-care workers are crucial in supporting and caring for patients (Heckemann et al., 2015). Within typical health organizations, nurses are the largest workforce and play a key role in the quality of care and health promotion (Maenhout and Vanhoucke, 2013). They include 62% of all the hospital staff (Momennasab et al., 2017). According to the National Association of Safety Professionals in the United States, nursing is one of the forty professions with a high prevalence of work-related stress (Yusefi et al., 2019). For that reason, workload is known to influence the behavior and performance of nurses in the workplace (Holland et al., 2019). Generally, the nursing workload is determined by time spent on patient care, nursing activities, and the skills needed to care for the patient (Myny et al., 2012). The nursing staff workload is clearly related to patient safety, quality of care, and cost of health care (Swiger et al., 2016).

The Intensive Care Unit (ICU) is an environment that provides care for patients with severe clinical conditions which require ventilation and acute medical clinical care (Ferreira et al., 2017). Nurses in ICUs have extensive and intense duties with limited variation in tasks, exposing them to extremely high workloads both physically and mentally (Mohammadi et al., 2015). There can be a need to react to both the demands of patients as well as their families. In addition, they are frequently making many decisions in relation to the urgent and critical conditions of patients' lives (Mohammadi et al., 2015). Abbey et al. (2012) report that nurses in the ICU perform 3,081 different activities during the day, 43% of which are performed simultaneously. Consequently, nurses may be at risk of making more errors with ICU patient care procedures, thus impacting on patient safety. In the ICU, the high workload and the low number of nurses per patient increases the risk of nosocomial infections in patients and mortality. Therefore, the ICU in the hospital is a

stressful work setting due to the complexity of patients and the high need for direct patient care (Hoogendoorn et al., 2019).

Given the importance of nursing workload in ICU and the factors that can affect it, this study aimed to determine the nursing workload in the ICUs and examine the association between nursing workload and patient and nurse characteristics.

2. METHODS

2.1. Design and Participants

A cross-sectional study was conducted on nurses and their patients under their care in the ICUs of five teaching hospitals affiliated to the ××× University of Medical Sciences, Rasht, Iran in 2015-2016.

In this study inclusion criteria for the recruitment of participants included: having an undergraduate/postgraduate degree in nursing, being responsible for the direct care of at least one patient alone during the shift, having at least one year's experience working in an ICU, having direct face to face care of a patient at least 4 hours in ICU per shift, and provision of signed consent to participate in the study. The exclusion criteria in this study included nurses who did not meet the inclusion criteria.

For sampling, the researchers contacted the study ICUs, then used face to face interviews to inform 124 nurses of the project and the participant inclusion criteria. Nurses responded to the researchers if they were interested. The nurses were screened by the study team to ensure they met the inclusion criteria.

2.2. Measures

2.2.1. Demographic Data Questionnaires

Two demographic data questionnaires were developed based on the review of the literature to collect demographic characteristics of nurses and the patients in their care. Nurses' demographic data questionnaires included questions about a nurse's gender, marital status, educational level, work experience, weekly working hours, employment at the other health care centers, resting before and after the work shift and type of ICU worked in. Patients' demographic data questionnaires contained questions about patients' gender, age, treatment types, referral sources, and length of ICU stay. Content and face validity methods were applied to confirm the validity of these questionnaires.

2.2.2. Nursing Activities Score

The Nursing Activities Score (NAS) was used in this study to determine nursing workload. The NAS designed by Miranda et al. (2003) measures the nursing workload in ICUs. This instrument consists of 23 items which are divided into seven major categories including basic measures, ventilation support, cardiovascular support, renal support, neurological support, metabolic support, and specific intervention. Each item is scored based on the amount of time the nurse spends on patient care. Although the original version of the NAS was validated to measure the workload of nursing over a 24 hour period, the modified version of this tool was validated by Debergh et al. (2012) to measure nursing workload per shift. In fact, for each patient, the scores of the NAS were calculated during each shift unless the time spent with a patient was less than 4 hours. The NAS ranges from 0 to 177 % that indicates the sum of scores of 23 items which demonstrates the percentage of time spent by a nurse on care-related tasks per ICU patient per 24 hours. Each NAS point corresponds to 14.4 minutes. Ideally, one nurse who provides care for two patients will obtain a score of 50% for each patient. A NAS of 100% is the ideal score for a nurse per shift in a 24-h period and would demonstrate that the nurse spent 100% of the working time caring directly for

patients. A NAS of above 100% indicates that more than one nurse is needed to perform caring activities. Therefore, a NAS of 177% also would equal 1.77 full-time equivalent ICU nurse time (Miranda et al., 2003, Debergh et al., 2012).

To evaluate the validity of the NAS, the original version with the available Farsi version (translated by Alizadeh et al., (2015)) was provided to 10 faculty members of the nursing school who specialize in this area. After collecting their opinions, corrective feedback was considered and the results (content validity ratio (CVR) = 93% and content validity ratio (CVI) = 90%) indicated a high validity of the Farsi version of the NAS. In addition, the equivalent reliability method was used to determine the reliability of the NAS. The NAS was completed by two evaluators simultaneously and separately for 17 nurses who were providing nursing care for ICU patients. The results showed there was a high correlation between the scores of two evaluators based on the Pearson correlation coefficient ($r = 0.81$ and $p < 0.001$). In addition, there was no significant difference between the mean of the two evaluator scores based on a paired t-test ($p = 0.72$).

2.3. Data Collection

Data were collected in six adult ICUs (two general ICUs with 19 beds, one neurosurgical ICU with 8 beds, one cardiac surgery ICU with 6 beds, one obstetric surgery ICU with 3 beds, and one burn ICU with 4 beds) of 5 hospitals during a fourth-month period from November 2015 to February 2016. The demographic questionnaire was completed on paper by the nurses and the patient demographic questionnaire was completed by the researchers during the study. The NAS was completed on paper for each nurse in three shifts (morning, evening, night). The researchers completed the NAS instrument in three mentioned shifts for each patient under the care of the nurses participating in the study based on direct observation of nursing activities, the information in the patient records and nursing reports. If the nurses were responsible for taking care of two

patients, the NAS was completed for each patient separately. Next, to obtain the score of the workload per shift, the scores of the NAS for each patient were summed together. Finally, the mean scores of the NAS in three shifts (morning, evening and night) were considered in relation to nursing workload.

2.4. Ethical Considerations

××× University of Medical Sciences approved the study protocol which was assigned the following code: IR.GUMS.REC.1394.286. The necessary permissions were obtained from the hospital authorities prior to the sampling. Next, information about the study was given to study participants (nurses and their patients/ patient companions). Then, the informed consent form was signed by participants who agreed to participate in this study. They were informed that they could opt-out of the study at any time without being penalized.

2.5. Data Analysis

Data were analyzed using the SPSS v. 25 software (IBM, Armonk, NY, USA) through descriptive and inferential statistics. Frequency and percent for qualitative variables and mean and standard deviation for quantitative variables were used to describe participants' characteristics. Nursing workload was described using means and standard deviations. In addition, an independent sample t-test and One-Way ANOVA were performed to compare nursing workload according to working shifts, patient genders, patient treatment types, and patient admission referrers. Moreover, multivariable linear regression analysis using the SATA software (Version 15, Stata Corporation, and College Station, TX, USA) was conducted to investigate nursing workload association with characteristics of nurses and patients. P-value < 0.05 was considered as a significant level.

3. RESULTS

Out of 124 nurses who work in six ICUs 7 nurses (5.6%) declined to participate in the study and 12 nurses (9.7%) including head nurses and assistant head nurses were excluded because they were not directly looking after patients. A total of 105 nurses (84.7%) who met the inclusion criteria were enrolled in the study. The majority of nurses in this study were female (96.2%), between the ages of 30-40 years old (61%), and married (59%). Most of them had a bachelor's degree in nursing (94.3%). Only 17.1% of nurses were employed at the other healthcare centers. In addition, 45.7% of nurses worked in general ICUs, 19% in a neurosurgical ICU, 20% in a cardiac surgery ICU, 10.5% in a obstetric surgery ICU, and 4.8% in a burns ICU were employed. The burns ICU had 14 nurses but due to a lack of patients at the time of the study only 5 nurses participated. Moreover, the mean (SD) of nurses' resting before and after the work shift was 33.43 (13.44) and 30.91 (11.73) hours, respectively. The mean number of patients under the care of nurses was 1.61 (0.40). Also, the mean of nurses' work experiences was 8.14 (4.72) years and the mean weekly working of them was 48.21 (8.59) hours.

Furthermore, 509 patients were under the care of nurses during the study period. The majority of patients in this study were male (56.6%). The mean age of patients participating in the study was 48.85 (20.31) years, and the mean length of stay on ICU for all participants was 6.31 (5.51) days. Most referrals to the ICU came from the operating theatre (52.3%) and emergency ward (34.6%). Of this sample, 63.1% of patients needed surgery and 36.9% required medical treatment only.

The mean (SD) of the nursing workload in three shifts (morning, evening, night) was 72.84% (22.07%). According to Table 2, there was a significant difference between the workload experienced by nurses on different work shifts ($p = 0.001$). It was noted that there were significant differences between the workload in morning shift in comparison with the evening shift (mean difference (MD) = 10.85, $p = 0.002$) and night shift (MD = 13.37, $p = 0.001$). Male patients

produced a significantly higher workload for nurses ($p < 0.001$) in contrast to female patients. Patients who received medical treatments caused a significantly higher workload for nurses than patients who had received surgery ($p < 0.001$). Moreover, a statistically significant association was identified between the nursing workload and patient referral sources ($p < 0.001$). Based on the post hoc test, there was a significant difference between the patients admitted from the operating theatre with patients admitted from the emergency ward ($MD = -4.80$, $p < 0.001$) and patients admitted from other ICUs ($MD = -7.99$, $p = 0.02$).

Based on the multivariable linear regression analysis, a positive association was found between nursing workload and female nurses ($b = 6.27$, 95% CI = 1.41, 11.13). Also, there was a direct association between workload of nursing and number of patients under their care ($b = 25.04$, 95% CI = 15.13, 34.96) and the length of patients' ICU stay ($b = 0.75$, 95% CI = 0.53, 0.97). Moreover, an inverse relationship was seen between nursing workload and working in neurosurgical ICU ($b = -7.91$, 95% CI = -12.91, -2.91), cardiac surgery ICU ($b = -14.58$, 95% CI = -20.87, -8.29), obstetric ICU ($b = -31.91$, 95% CI = -39.15, -24.67), and burns ICU ($b = -31.18$, 95% CI = -41.22, -21.14) (Table 2).

4. DISCUSSION

The purpose of this study was to determine the nursing workload in ICUs and investigate the association between nursing workload and patients' and nurses' characteristics. In this study, the mean NAS of the nursing workload was reported at 72.84%. The average nursing workload in ICUs reported in other studies shows a wide variation (Esmaeili et al., 2015). A study of multidisciplinary ICUs in Norway showed that the nursing workload was 96.2% using the NAS tool (Stafseth et al., 2011). The findings of a recent study conducted in Brazil revealed that the nursing workload using the NAS in ICUs is lower at 63.5% (Strazzieri-Pulido et al., 2019). The

discrepancy of nursing workload in these studies could be due to different nurse staff frameworks and organizations, differences in the types of patients admitted to ICUs and the technical and practical differences in the use of the NAS tool (Stafseth et al., 2011, Strazzieri-Pulido et al., 2019, Padilha et al., 2015).

To our knowledge, this study is one of the limited studies (Bruyneel et al., 2019, Debergh et al., 2012) that evaluated the NAS for individual nurses across all three shifts. In comparison to evaluating the NAS over 24 hours, evaluation using the NAS per shift can possibly provide better data to determine a precise nurse-patient ratio. The findings of the current study indicated that ICU nurses experience a higher workload in the morning shift than in the evening and night shifts., despite having a higher number of nurses in the morning shift (Ducci et al., 2008). Most patient admissions, patients discharges, patient treatment procedures and follow-up administration are performed during the morning shift (Armstrong et al., 2015). In addition, the number of nurses does not decrease significantly in evening and night shifts in ICUs despite the possibility of new patient admissions or the deterioration of patients' conditions (Debergh et al., 2012). Findings of a study undertaken in 16 hospitals in Belgium demonstrated that ICU nurse workload in the morning shift was considerably higher than evening and night shifts (Bruyneel et al., 2019). Debergh et al.'s (2012) study also showed that workload in the night shift is lower than evening and night shifts.

The results of the present study identified that male patients were associated with a higher workload for ICU nurses. Similarly, findings of another study also showed that male trauma patients in ICUs create a higher workload for nurses (Nogueira et al., 2014). Two other studies also found a positive association between male patients and increased nursing workload in ICUs (Padilha et al., 2008, Samuelsson et al., 2015). Although evidence is currently limited, it has been

suggested by some previous studies that male patients are more likely to be hospitalized in ICUs and as a result of severe injuries, are likely to receive aggressive life support (Mahmood et al., 2012, Fowler et al., 2009).

In our study, patients admitted with specific medical diagnoses ' were associated with a higher workload than surgical admissions. In addition, there was a direct association between having a higher nursing workload for nurses working in general ICUs. Similarly, Padilha et al.'s (2007) study results highlighted that nursing workload in general ICUs was higher than surgical and burn ICUs. Lucchini et al. (2015) used the NAS to evaluate nursing workload on ICUs and found general ICUs in contrast with surgical ICUs imposed a higher workload for nurses. The higher nursing workload of general ICUs may be due to the increased complexity and intensity of patient care such as the need for hygiene procedures, mobilization, and positioning (Reich et al., 2015, Lucchini et al., 2015). Furthermore, Padilha et al. (2008) documented that patients receiving medical treatments in comparison with those who have had surgery created a higher nursing workload in ICUs. Although according to our data, the type of patients' treatments and type of ICU can be considered one of the factors that may influence the workload of nursing in different ICUs, the previous studies have demonstrated that the intensity of the patient's condition more important predictor of nursing workload in clinical practice (Altafin et al., 2014, Nogueira et al., 2014, Romano et al., 2019). For instance, Altafin et al. (2014) found patients who died required a higher workload for ICU nurses than those who survived.

In our study, a significant association was identified between nursing workload and patient referral source. The referral sources of ICU patients can help predict nursing workload (Padilha et al., 2008). Consistent with our results, another study found that the mean percentage NAS for patients admitted from the emergency department was higher than for those admitted from the operating

theatre and general ward (Armstrong et al., 2015). However, this study also reported that the workload of patients who were admitted from other ICUs was not high which is in conflict with our results (Armstrong et al., 2015). Romano et al. (2019) in their study concluded the type of admission to ICUs provides no valuable guidance to predict the required nursing workload for patient care. This is inconsistent with our study and other published studies (Coelho et al., 2011, Padilha et al., 2008).

Our study found a direct association between nursing workload and the number of patients under the care of nurses which would be expected. Similarly, previous studies also showed a significant relationship between the number of patients and the nursing workload (Penz et al., 2007, Coventry et al., 2015). In fact, when the number of patients increase, the responsibility of nurses and the time spent on direct patient care increases (Yusefi et al., 2019, Hugonnet et al., 2004, Halwani et al., 2006).

We showed that there was a direct association between the patients' length of stay on ICU and nursing workload. The relationship between NAS and length of ICU stay in the literature is conflicting. Consistent with our findings, Padilha et al. (2008) reported that patients who remain longer in the ICUs, for each extra ICU-day, have a 7.0% more probability of increasing the NAS. Lucchini et al. (2014) during a five-year study with 5856 patients found the NAS was high in patients with the increasing length of ICU stay. However, findings of another study revealed that the NAS decreased with increasing patient length of stay in the ICU (Altafin et al., 2014).

In the present study, we found a direct association between the nursing workload and female nurses. Consistent with our findings, Hoonakker et al. (2011) and Mirzaei et al. (2015) found female nurses in ICUs experienced a higher workload. Female nurses may, in addition to the stressful work environment in ICU face personal stressors including daily housework, parenting,

and childcare demands, and challenges to the work-life balance that lead to perceived high workload and burnout (Papazian et al., 2018).

4.1. Implications and Recommendations for Practice

Our study extends the previous knowledge about nursing workload in ICUs and their related factors. The findings of this study can be used by nursing and hospital managers to provide an appropriate allocation of nursing staff on ICUs with additional consideration given to nurse and patient characteristics, and can therefore improve the quality of care in ICUs. However, nurse and patient characteristics should not be considered as the only predictive factors of nursing workload in ICUs.

4.2. Strengths and Limitations

Our study investigated and measured the workload of each nurse in the morning, evening and night shifts, therefore differing from the other studies cited in our literature review. Our study has several limitations that should be considered. Firstly, a cross-sectional design was used in this study; therefore, the results should not be considered causal. Secondly, this study was conducted in Iran, which possibly decreases the generalizability of the results to other countries. Thirdly, the NAS tool was originally developed to be applied over a 24-hour period. Although Debergh et al. (Debergh et al., 2012) demonstrated that it could be used per shift, it seems that using this tool per shift requires further validation in larger studies. Fourthly, although the results showed a significant association between workload and nursing gender, this finding may be due to a greatly uneven number of male nurses in our sample. Finally, the data for this study were collected about 4 years ago which could generate bias.

Conclusion

284 Our study shows that the nursing workload in ICUs was associated with both nurse and patient
285 characteristics. Type of work shifts, nurse gender, type of ICU which the nurses worked in, the
286 number of patients under a nurse's care, patient gender, medical or surgical treatment for patient,
287 patient referral source, and the length of patient ICU stay influenced nursing workload. Future
288 research should focus on gathering more clinical patient data in order to extend our study findings
289 regarding the relationship between nursing workload, patient characteristics and nurse
290 characteristics.

291 **Impact**

292 **WHAT IS KNOWN ABOUT THIS TOPIC**

- 293 • Some of the previous studies about nursing workload in an ICU and the associations with
294 nurse and patient characteristics present conflicting outcomes.

295 **WHAT THIS PAPER ADDS**

- 296 • Type of work shifts, nurse gender, type of ICU which nurses work in and the number of
297 patients under care were nurse characteristics that influenced workload.

298 Patient gender, patient ICU requirements, patient referral source, the length of patient ICU stay
299 were patient characteristics that influenced nursing workload.

300

301

Table 1. Comparison of nursing workload according to work shift, patient gender, patient treatment types, and patient referral sources

Variables		Workload Mean (SD)	Test	p-value
Work shift (workload per shift)	morning	81.46 (25.94)	F-value = 6.94	0.001*
	evening	70.61 (26.01)		
	night	68.09 (23.17)		
Patient gender (workload per patient)	male	47.78 (12.23)	t-value = 5.77 Df = 507	< 0.001**
	female	41.55 (11.85)		
Patient treatment types (workload per patient)	surgical	42.89 (11.04)	t-value = 5.30 Df = 507	< 0.001**
	medical	48.80 (13.79)		
Patient referral sources (workload per patient)	Operation theatre	42.93 (11.16)	F-value = 6.42	< 0.001*
	Emergency ward	47.73 (10.36)		
	General wards	45.57 (9.97)		
	Other ICUs	50.92 (41.04)		

* One-Way ANOVA

** Independent samples t-test

Df : degree of freedom.

306 Table 2. Association between nursing mean workload with individual and occupational characteristics of
 307 ICU nurses and their patients' characteristics

Nurses characteristics	b*	SE**	95% CI***	p-value
Female	6.27	3.96	1.41, 11.13	0.01
Age (ref [#] to < 30)				
30-40	2.59	2.93	-3.16, 8.35	0.37
> 40	2.78	7.44	-11.81, 17.37	0.70
Married	-2.98	1.86	-6.62, 0.66	0.10
Educational level (ref to Bachelor)				
Master	0.20	3.73	-7.10, 7.51	0.95
Work experience	0.42	0.34	-0.24, 1.09	0.21
Weekly working hours	0.31	0.11	-0.12, 0.74	0.08
Being employed at the other health care centers	3.02	2.46	-1.80, 7.84	0.21
Resting before the work shift	0.18	0.07	-0.07, 0.43	0.07
Resting after the work shift	0.01	0.07	-0.13, 0.16	0.83
Number of patients under care	25.04	5.05	15.13, 34.96	< 0.001
Type of ICU (ref [#] to General ICUs)				
Neurosurgical	-7.91	2.55	-12.91, -2.91	0.002
Cardiac surgery	-14.58	3.20	-20.87, -8.29	< 0.001
Obstetric surgery	-31.91	3.69	-39.15, -24.67	< 0.001
Burn	-31.18	5.12	-41.22, -21.14	< 0.001
Patients characteristics				
Age of patients	-0.02	0.12	-0.26, 0.21	0.82
Length of ICU stay	0.75	0.23	0.53, 0.97	0.02

* b coefficient was obtained according to the multivariable linear regression

** Standard error

*** Confidence interval

[#] Reference group

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